# CLAIMS

1. An electro-optical system, comprising:

a plurality of electromagnetic gain media having a corresponding plurality of apertures thereof disposed in a predetermined spatial distribution;

a refracting surface disposed to intercept energy from the plurality of apertures; and

a partially reflecting surface to direct portions of the intercepted energy back toward the plurality of apertures with the directed energy being distributed about the plurality of apertures.

2. The system of Claim 1 wherein such refracting surface is spaced from the plurality of apertures by approximately one half a focal length of the refracting surface.

3. The system of Claim 1 wherein the plurality of apertures have a corresponding Fourier plane and the apertures are disposed in said Fourier plane.

4. The system of Claim 1 wherein the plurality of apertures have a corresponding Fourier plane and said Fourier plane is overlaid back onto the apertures by means of the refracting surface and the partially reflecting surface.

5. The system of Claim 1 wherein the plurality of apertures have a corresponding spatial frequency plane and the plurality apertures are disposed in said spatial frequency plane.

6. The system of Claim 1 wherein the gain media is at least one of

a diode pumped fiber laser;

a fiber coupled diode laser;

a gas laser;

a diode pumped solid state laser; and

a monolithic laser diode array.

7. The system of Claim 6 wherein the diode pumped solid state laser is at least one of:

a Nd:YAG laser;

a Ruby laser;

a Nd: YLF; and

a Ho:YAG.

8. The system of Claim 1 further comprising:

a cavity having a first surface; and

wherein the plurality of apertures is disposed on said first surface to couple radiation from the plurality of gain media into said cavity.

9. The system of Claim 8 at least one spatial Fourier transform of a pattern of the intercepted energy is achieved upon a single round trip through the external cavity.

10. The system of Claim 9 wherein the at least one Fourier transform of the pattern is overlaid on itself.

11. The system of Claim 9 wherein the plurality of apertures is disposed in a predetermined spatial distribution such that a corresponding intercepted energy pattern has a plurality of intensity peaks at corresponding locations of the at least one Fourier transformed intensity pattern that is achieved through the action of the cavity.

12. The system of Claim 1 wherein the spatial distribution is predetermined such that the energy being distributed about the plurality of apertures of the gain media is initially

directed to a plurality of frequency conversion devices.

13. The system of Claim 12 wherein the frequency conversion devices are frequency doubling crystals.

14. The system of Claim 1 wherein the predetermined spatial distribution provides a spatial filter establishing a composite beam comprised of energy from the plurality of gain media with phase coherency.

15. The system of Claim 14 wherein the refracting surface is closer to the partially reflecting surface than a Talbot distance $2D^2/\lambda$, where $\lambda$ is a nominal wavelength of the composite beam and D is a spacing between each of the plurality of apertures and a corresponding nearest neighboring aperture.

16. The system of Claim 1 wherein the refracting surface is a lens.

17. The system of Claim 1 wherein the partially reflecting surface is a mirror.

18. The system of Claim 1 wherein the refracting surface is adjacent to the partially reflecting surface.

19. The system of Claim 1 wherein the regions of constructive interference are disposed on the apertures producing an output of the system a composite beam comprised of energy from the plurality of gain media with phase coherency.

20. The system of Claim 1 wherein the predetermined spatial distribution provides a spatial filter establishing a composite beam by combining in parallel the energy from each of the plurality of gain media.

21. The system of Claim 1 wherein the plurality of apertures includes N apertures where N is greater than two.

22. The system of Claim 21 wherein portions of the intercepted energy is directed to each of the plurality of N apertures.

23. The system of Claim 1 wherein the plurality of apertures are located in corresponding Fourier planes.

24. The system of Claim 1 wherein the refracting surface and the partially reflecting surface direct the energy emitted from the each of the plurality of apertures, substantially over the plurality of apertures.

25. The system of Claim 1 wherein the plurality of apertures is disposed such that an interference pattern of the energy has a plurality of relatively high intensity spots at substantially the same position as a plurality of the energy.

26. The system of Claim 1 the energy has an input spatial pattern which has a relatively high degree of coupling with a Fourier transform of the input energy spatial pattern.

27. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution;

a common optical element disposed to intercept energy from the plurality of electromagnetic gain media and partially direct the energy back toward the plurality of apertures of the plurality of gain media with the directed energy being distributed about the plurality of gain media; and

wherein the predetermined spatial distribution provides a spatial filter establishing

a composite beam comprised of energy from the plurality of gain media with phase coherency.

28. The system of Claim 27 wherein the composite beam is a laser beam.

29. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution;

a common optical element disposed to intercept energy from the plurality of electromagnetic gain media forming an interference pattern across the apertures, such interference pattern having regions of constructive interference and regions of destructive interference; and

wherein the regions of constructive interference are disposed on the apertures producing an output of the system a composite beam comprised of energy from the plurality of gain media with phase coherency.

30. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution;

a common optical element disposed to intercept energy from each of the plurality of electromagnetic gain media and direct the energy from each of the plurality of gain media back toward the plurality of apertures of the plurality of gain media with the directed energy being distributed about the plurality of gain media; and

wherein the predetermined spatial distribution provides a spatial filter establishing a composite beam by combining in parallel the energy from each of the plurality of gain media.

31. The system of Claim 30 wherein the composite beam is a composite phase coherent laser beam.

32. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution;

a common optical element disposed approximately to intercept energy from the plurality of electromagnetic gain media and direct the energy back toward the plurality of apertures of the plurality of gain media with the directed energy being distributed about the plurality of gain media, such common optical element comprises a lens adjacent to a partially reflecting surface.

33. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution;

a common optical element disposed approximately to intercept energy from the plurality of electromagnetic gain media and partially direct the energy back toward the plurality of apertures of the plurality of gain media with the directed energy being distributed about the plurality of gain media, such common optical element comprises a Fourier transform lens adjacent to a partially reflecting surface.

34. An electro-optical system, comprising:

a plurality of electromagnetic gain media having apertures thereof disposed in a predetermined spatial distribution having a spacing D;

a common optical element having a refracting surface and a partially reflecting surface, and to direct the energy back toward the plurality of apertures of the plurality of gain media with the directed energy being distributed about the apertures, such common optical element being spaced apart from the apertures to intercept energy from the plurality of electromagnetic gain media by approximately a distance $D^2/\lambda$, where $\lambda$ is a nominal wavelength of an output beam.

35. An electro-optical system, comprising:

a plurality of electromagnetic gain media having a corresponding plurality of apertures thereof disposed in a predetermined spatial distribution;

a common optical element comprising:

a refracting surface disposed to intercept energy from the plurality of apertures;

a partially reflecting surface to direct a portion of the intercepted energy back toward the plurality of apertures with the directed energy being distributed among the plurality of apertures; and

such common optical element being spaced apart from the plurality of apertures by approximately one half a focal length of the common optical element.

36. The system of Claim 35 wherein the common optical element is a reflector having optical power.

37. The system of Claim 36 wherein the reflector comprises a lens disposed on a partially reflective surface.

38. The system of Claim 37 wherein the reflector partially reflects the directed energy and partially transmits the directed energy to form an output beam.

39. A cavity for combining electromagnetic energy from a plurality of electromagnetic gain media having a corresponding plurality of apertures, comprising:

a housing having a first surface;

a plurality of slots disposed on said first surface in a predetermined spatial distribution to receive the plurality of electromagnetic gain media;

a common optical element disposed to intercept energy passed through the plurality of apertures; and

wherein the predetermined spatial distribution provides a spatial filter establishing a composite beam comprised of energy from the plurality of gain media with phase

coherency.

40. A method to produce a phase coherent beam comprising:

providing a plurality of apertures for a plurality of electromagnetic gain media producing a plurality of radiation beams;

providing a refracting surface and a partially reflecting surface disposed to reflect portions of the radiation beams;

spacing each of the plurality of apertures apart in a predetermined spatial distribution to provide a spatial filter establishing a composite beam comprised of energy from the plurality of gain media with phase coherency.